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A CLOUD SHADOW DETECTION BASED ON C1C2C3 AND LAB COLOR MODEL IN SATELLITE AERIAL IMAGE

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ABSTRACT

Shadow is creating because the light source blocked by any object. Clouds and cloud shadows are absolutely common in satellite captured images. Cloud Shadows degenerate quality of images and affect the information so the correct image analysis it is important to detect a cloud shadow and claim the misplaced information. Thus, cloud Shadow detection in real scene images is a challenging but interesting area. The main aim of this paper is to provide a methodology for estimation and detection of cloud shadows region in images. The proposed method takes advantage of C1C2C3 & LAB color model and fuzzy & L segmentation.

KEYWORDS: Image enhancement, Cloud shadow detection, Color model information, Segmentation, Canny edge detection.

INTRODUCTION

Image processing is learning of image to image as input-output transformation. Image processing has one of the most research area that the interest of broad variety researchers. Shadow will occur by sunlight or any light sources so cannot get clear and quality picture for obtain the shadow in the images. Shadows in digital images are troublesome in image processing. Cloud shadows are common feature in remote sensing images [3]. Many applications it is very necessary to detected cloud shadows from the required satellite aerial images. Cloud shadow problem is interference in different applications such as study of land cover, environmental monitoring, vegetation, geographical visualization and land use classification and they can loss of information in the image [4].

A shadow is generated because the direct light fallen from any source of lighting and then its blocked either totally or partially by an object. If the light energy is transmit more, that area is represented as non shadow region whereas if the light energy is fallen less, this area is represented as shadow region. When light is cut off an image is created known as shadow. There are two types of department into shadow, once is self shadow and second is cast shadow [7]. Self-shadow is objects itself and another is cast-shadow. Both self and cast shadow has various brightness values. The brightness of all the shadows in an image depends on the reflectivity of the object. Self shadows commonly have a bigger value brightness than cast shadows so they receive more secondary lighting from surrounding illuminated objects.

There are two types of cast shadow, once is umbra and second is penumbra [6]. When light is a fallen on an object and its direct light is completely blocked by its object is called umbra cast shadow. Other one has a penumbra cast shadow a direct light is partially blocked by its object so it's called penumbra cast shadow. Both are the part of a cast shadow. These regions are created due to multiple lighting and the difference between the two lies in the contrast they have to the background [13].

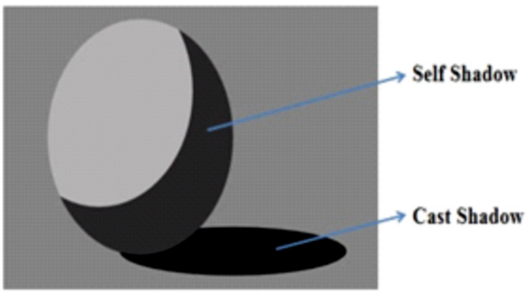

Fig. 1: Types of shadow [8]

Some relevant work has been previously done in the area of cloud shadow detection. In proposed of Namrita Singh [2] a method to detect cloud shadows using C1C2C3 color model and Fuzzy Logic based shadow detection image analysis. First transform color aerial image in to C1C2C3 color model then apply fuzzy thresholding using minimize fuzzy divergence value it means the dividing between shadow and non-shadow pixels then apply morphological operation opening and closing have been used in order to eliminate apart from others pixels. In next step is edge detection to segment images based on changes in intensity for separates two disjoint regions. Shadow detection algorithms using the feature of the C1C2C3 color model, the C3 component without processing makes the results unsatisfactory [5]. This method was work on satellite captured cloud and cloud shadows images but given results were minute misdetections. So the existing method algorithm needs to be modified for the system is can be enhanced to produce better results for shadow fine boundaries and more accurate results.

PROPOSED METHODOLOGY

I. Color Model

A color model is describes the range of colors with its different vector values. Color can be represented in a variety of dimensional spaces such as RGB, HSV, YIQ, C1C2C3, Lab, etc. As some color features of the shadow areas and the non-shadow areas are totally various. It invariant features color model such as some colour models are invariant to changes in the imaging conditions including lighting conditions & viewing direction and shadows. A color model that is invariant features to shadow or luminance can be used to detect shadows in real scene images.

A. C1C2C3 Color Model

A C1C2C3 color model as described in [2] is defined as follows:

$$C1= \tan^{-1} R / MAX(G,B) \tag{1}$$

$$C2= \tan^{-1} G / MAX(R,B) \tag{2}$$

$$C3= \tan^{-1} B / MAX(R,G) \tag{3}$$

Where, C1,C2,C3 are first, second and third chrominance components respectively; R,G,B are red, green and blue color components in RGB image respectively. C1C2C3 color model was chosen for cloud shadow detection segment because of its property to comparatively dull pixels such as cloud and his background in the image [2].

B. LAB Color Model

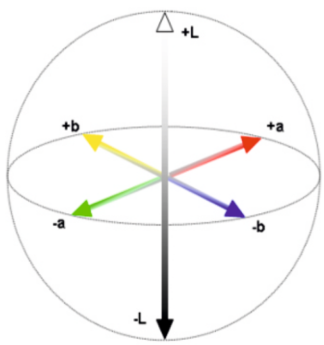

Fig. 2: LAB color model [12]

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The LAB colour has three channels. LAB color model is work on soft shadow in the images. First L is the Lightness channel. Second A and B are the two colour channels. The L channel has ranging values from 0 to 100, which represent to various shades from black to white. Then the A channel has values ranging from −128 up to +127 and gives the red to green ratio and also The B channel also has ranging values from −128 up to +127 and gives the yellow to blue ratio. High value in A or B channel represents a colour having more red or yellow and a low value represents a colour having more green or blue [11].

II. Segmentation

Segmentation is the process of partitioning an image into its constituent parts or objects.

A. Fuzzy Segmentation

Fuzzy thresholding is a great method for segmentation that overcomes a lot of misclassification problems of the state of art techniques. It gives a degree of belief that a certain pixel is cloudy or not. In this fuzzy thresholding minimize fuzzy divergence value is defined as the difference between actual and automatic threshold image [2]. Then thresholding Membership value is given by gamma distribution and is calculated to each pixel then stored in a matrix form to each threshold value. One threshold value satisfies only one condition which indicates the quantity of pixels belonging to background and cloud or cloud shadow.

It is defined as following [2]:\

$$\mu_0 = \frac{\sum_{g=0}^{t} g.\mathrm{count}(g)}{\sum_{g=0}^{t} \mathrm{count}(g)} \tag{4}$$

$$\mu_1 = \frac{\sum_{g=t+1}^{L-1} g.\mathrm{count}(g)}{\sum_{g=t+1}^{L-1} \mathrm{count}(g)} \tag{5}$$

If gij ≤ 1 for background then,

$$\mu(gij) = \exp(-c.\ |gij-\mu0|) \tag{6}$$

If gij > l for cloud shadow object then,

$$\mu(gij) = \exp(-c.\ |gij-\mu1|) \tag{7}$$

Where, g=0,1,2...,255; count(g)=no. of occurrences of gray level g in the image; L=image size; gij=(i,j)th pixel of the image; t=threshold value; c=1/(gmax-gmin)

B. L Segmentation

In LAB color model compute the mean values of the pixels in L, A and B planes of the image separately. If mean (A) + mean (B) ≤ 256 so Classify the pixels with a value in L ≤ (mean (L) – standard deviation (L)/3) as shadow pixels and others as non-shadow pixels. Otherwise the classify pixels with lower values in both L and B planes as shadow pixels and others one as non-shadow pixels.

III. Morphology

Morphological processing extracting image components that are useful in the representation and description of shape and this operation are needed in order to remove isolated shadow pixels in a non-shadow area and also isolated non-shadow pixels in a shadow area. Morphological operations are two types, erosion and dilation [7]. Erosion is used for thinning any image element and dilation performs thickening any image element.

IV. Edge detection

Edge detection is one of the most commonly used operations in image analysis, and there is use for enhancing, classification of object and detecting edges. A set of connected pixels which separate two disjoint regions is known as an edge. Basically edge detection techniques identify points in a digital image where brightness changes sharply and detect missing pixels. Since, detection quality, unambiguity and accuracy is good in canny edge [4] detector it use. The Canny edge detector is uses a multi-stage algorithm and it determine cloud shadow edges.

V. Block Diagram Start

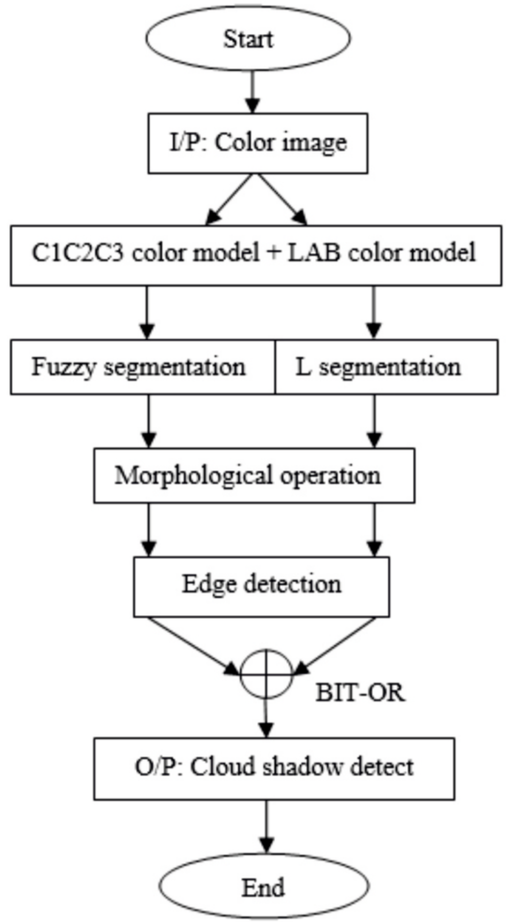


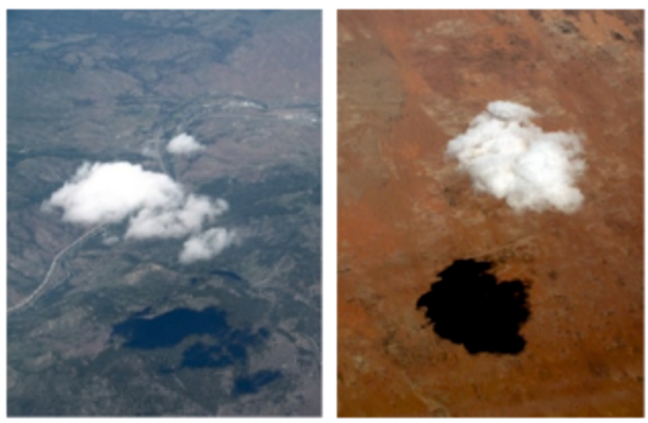
Fig. 3: Block diagram of the system

VI. Algorithm Flow of the Proposed Method

The proposed method includes major steps as follow:

- **Step1:** Input as a remote sensing color image and transferring the remote sensing color image into C1C2C3 color model and LAB color model.
- **Step2:** Then calculating the shadow features image, fuzzy segmentation and L segmentation operation is performing in color model respectively C1C2C3 and LAB color model image to acquire candidate image.
- **Step3:** Enhance the outline of the shadow area by applying operations is morphology. Morphological operations such as dilatation and erosion are eliminating any outlier pixel within the boundary of shadow and work on shape information of shadow areas in the image.
- **Step4:** The transition in between shadow and non-shadow areas can raise problems so using edge detection algorithm like canny, bordered image is achieved and apply BIT-OR operation for combine two candidate images. Finally achieved the shadow image.

EXPERIMENTAL RESULTS



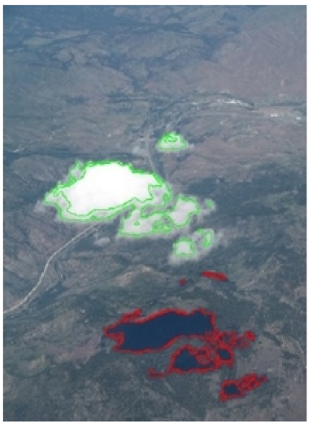
(a) **(b)**

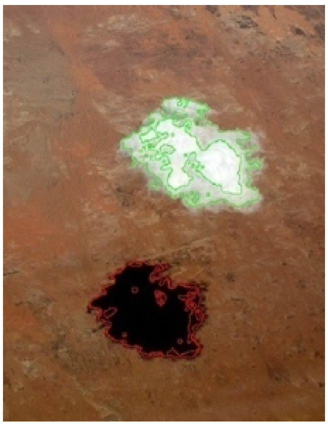
(c)

(d)

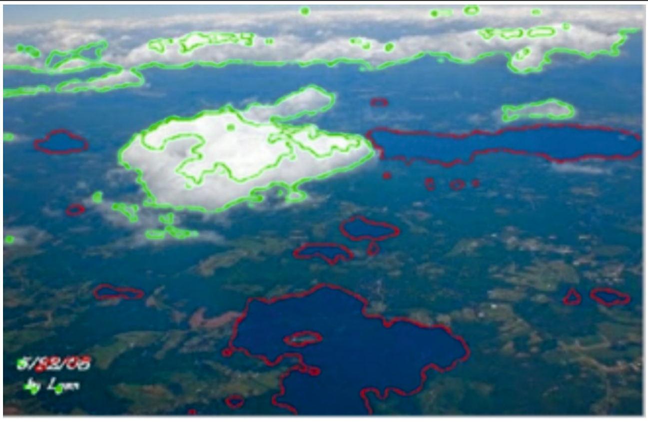
(e)

Fig. 4: (a), (b), (c), (d), (e) is satellite images of cloud and cloud shadow obtained from internet.





(a) **(b)**



(c)

(d)

(e)

Fig. 5: (a), (b), (c), (d), (e) is detected clouds (Green) and cloud shadow (red)

On application of algorithm to some satellite aerial images, the results passed output to be the satisfactory. Following are the experimental results on some cloud and cloud shadow images. Fig. 5 (a), (b), (c), (d), (e) shows the results of cloud and cloud shadow estimation as applied to the original images in fig. 4 (a), (b), (c), (d), (e). In the below results cloud and cloud shadow edges were effectively detect them. Detected clouds in the images are enclosed with green boundary and shadows with red boundary.

EXPERIMENTAL PARAMETERS

In order to analyze the different shadow detection methods, for detecting the shadow result in satellite through captured aerial images of clouds and cloud shadows in system. I will use Matlab R2013b instances as laptop computers with 2.30 GHz Intel(R) Core(TM) i5 processor and 4 GB RAM having Windows 8 (64 bit) Operating system with webcam. For evolution of algorithm, I am use the True Positive Rate (TPR) and True Negative Rate (TNR) as evaluation parameter. Following is the equation of TPR and TNR

$$TPR = Ntp/(Ntp+Nfn) \quad (8)$$

TNR= Ntn/(Ntn+Nfp) (9)

Where Ntp, Nfn, Ntn and Nfp are the number of objects identified As true positive (TP) denotes the number of true shadow pixels which are identified correctly, false negative (FN) denotes the number of true shadow pixels which are identified as non-shadow pixels,true negative (TN) is the number of non-shadow pixels which are identified as true shadow pixels, false positive (FP) denotes the number of non-shadow pixels which are identified correctly as of evaluation parameter.

CONCLUSION

Image processing studies image to image transformation. The input and output both are images in image processing. The given algorithm is implemented on few satellite captured images of cloud and cloud shadows, and the results were found to be appreciable. The shadow detection algorithm detects all shadows present in the images. Only images with clouds and his cloud shadows have been tested. Although, detected shadows are accurate for fine boundaries good agreement with shadow borders, but the small objects is lightly detected and highland vegetation areas quite precise though minute misdetections are there. The algorithm needs to be modified for stereotype cloud shadows images. The system is can be enhanced to produce better, more accurate and precise results.

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